# EVALUATION OF ROLE OF MAGNETIC RESONANCE IMAGING IN BREAST LESIONS: A PROSPECTIVE STUDY

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## ABSTRACT

**Background:** There has been an increasing interest in magnetic resonance imaging (MRI) as a non-invasive diagnostic modality for further characterizing suspicious breast lesions detected with mammography or ultrasound. This study was designed with the primary aim to study usefulness of MRI in patients presenting with breast related complaints.

**Methods and Materials:** Our study group consisted of 30 lesions in 28 patients chosen for breast MRI, for lesions suspicious of malignancy and for pre-operative evaluation in diagnosed cases of carcinoma breast. The imaging was performed on 1.5 T Phillips ACHIEVA MRI machine with dedicated breast coil & Siemens MAMMOMAT mammography machine. Standard protocols for MRI breast were followed as per the institutional guidelines.

**Results and conclusion:** In our study, we successfully used MRI–BIRADS lexicon for describing lesion morphology. MR imaging can be utilized as an important breast imaging modality as complimentary tool. Both malignant and benign lesions are identified more confidently with high-resolution MR imaging compared to conventional mammography.

**Keywords:** Magnetic Resonance Imaging; Breast lesions; Mammography.

## INTRODUCTION

Breast cancer is the most frequently occurring malignant disease in women with a lifetime risk of 1 in every 8–9 women.[1] In recent years, there has been an increasing interest in magnetic resonance imaging (MRI) as a non-invasive diagnostic modality for further characterizing suspicious breast lesions detected with mammography or ultrasound.[2] The additional value of breast MRI lies mainly in its capacity to detect multicentric and multifocal disease, to detect invasive components in ductal carcinoma in situ lesions and to depict the tumor in a 3-dimensional image.[3] Breast MRI therefore has the potential to improve the diagnosis and provide better preoperative staging and possibly surgical care in patients with breast cancer. Breast MRI has been used increasingly in the preoperative evaluation of women with newly diagnosed breast cancer.[4] Despite its rapid adoption, limited evidence exists to support the routine use of breast MRI.

MRI of the breast is not a replacement for mammography or ultrasound imaging but rather a supplemental tool.[5] MRI of the breast offers valuable information about many breast conditions that cannot be obtained by other imaging modalities, such as mammography or ultrasound.[6] This study was designed with the primary aim to study usefulness of MRI in patients presenting with breast related complaints.

## MATERIALS & METHODS

During the period of July 2011 to November 2013, a prospec

tive study in patients presenting with breast related complaints was carried out. Relevant history of illness and significant clinical findings of all patients were recorded. Previous investigations were reviewed and recorded. The imaging was performed on 1.5 T Phillips ACHIEVA MRI machine

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with dedicated breast coil & Siemens MAMMOMAT mammography machine. Standard protocols for MRI breast were followed as per the institutional guidelines.

Intravenous contrast medium was administered to all cases using gadopentate dimeglumine, 0.1mmol/kg body weight, given by automatic robotic injector. Post contrast T1weighted axial sequences were performed keeping the parameters constant and in few cases the T1W sequences were repeated after 5 minutes and after 10 minutes. During the MRI examinations, breasts were held firmly in place by using cushion of varying sizes inserted in coil openings to minimise motion artefacts. Reports from light microscopic studies were obtained by histopathological analysis. The management decision, follow up, outcome and histopathological diagnosis were recorded. The results of this study were analyzed and compared with other available studies in literature.

## RESULTS

Our study group consisted of 30 lesions in 28 patients chosen for breast MRI, for lesions suspicious of malignancy and for pre-operative evaluation in diagnosed cases of carcinoma breast. In our study, we successfully used MRI–BIRADS lexicon for describing lesion morphology. The morphologic criterion based on MRI BIRADS was effective for differentiating between benign and malignant breast lesions in high-spatial-resolution images regardless of their histological variability. In our study, in majority of cases, we were able to correctly diagnose breast lesions based on certain morphologic features. Among the 30 lesions, 22 lesions were benign & 8 lesions were malignant. Out of 28 patients, mammography was not possible or was avoided in 3 patients because of painful breast or young age of patient. Out of 28 patients mammography was inconclusive in 2 patients because of dense breasts. The age incidence in the study was from 15yrs to 70 yrs. The age distribution of patients is shown in Table 1.

**Table No. 1: Age Distribution**

| S.No. | Age Range | No. of Patients | Percent |
|---|---|---|---|
| 1 | 11- 20 | 1 | 3.5% |
| 2 | 21 – 30 | 5 | 17.8% |
| 3 | 31 – 40 | 10 | 35.7% |
| 4 | 41 – 50 | 7 | 25% |
| 5 | 51 – 60 | 4 | 14.2% |
| 6 | 61 – 70 | 1 | 3.5% |
| | **TOTAL** | **28** | **100%** |

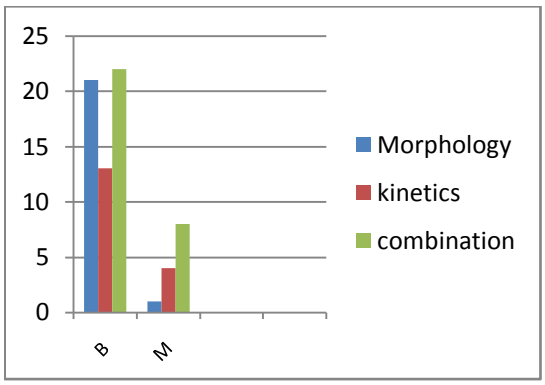


**Table No. 2: MRI DESCRIPTION OF LESION USING BIRADS LEXICON**

| LESION | Malig-nant (on histopa-thology) | % | Benign (on histopa-thology) | % |
|---|---|---|---|---|
| Mass | 6 | 75% | 16 | 72.7% |
| Non mass | 2 | 25% | 2 | 9% |
| Focus | 0 | 0% | 2 | 9% |

**Table No. 3 : MASS MORPHOLOGIC DESCRIPTORS**

| Feature | Characteristic | Malignant | Percent | Benign | Percent |
|---|---|---|---|---|---|
| Margin | | | | | |
| | Smooth | 1 | 12.5% | 14 | 63.6% |
| | Irregular | 2 | 25% | 2 | 9% |
| | Spiculated | 3 | 37.5% | 0 | 0% |
| Shape | | | | | |
| | Oval/round | 1 | 12.5% | 6 | 27.2% |
| | Lobulated | 2 | 25% | 8 | 36.3% |
| | Irregular | 3 | 37.5% | 2 | 9% |
| Enhancement | | | | | |
| | Homogenous | 3 | 37.5% | 5 | 22.7% |
| | Heterogenous | 3 | 37.5% | 9 | 40.9% |
| | Rim enhancement | 2 | 25% | 0 | 0% |
| | Dark septations | 0 | 0% | 3 | 13.6% |
| | No enhancement | 0 | 0% | 7 | 31.8% |

**Table No. 4: Non mass morphologic descriptors**

| Distribution | Malig-nant | % | Benign | % |
|---|---|---|---|---|
| Regional | 1 | 12.8% | 0 | 0% |
| Segmental | 1 | 12.8% | 1 | 4.5% |
| Diffuse | 0 | 0% | 1 | 4.5% |

**Table No. 5: Frequency of visually assessed kinetic patterns**

| Curve | I | II | III |
|---|---|---|---|
| Benign | 13 | 7 | 0 |
| Malignant | 1 | 3 | 4 |

**Table No. 6: Comparison of benign & malignant diagnostic accuracy on basis of morphology, kinetic analysis and combination of two, in reference to histopathological diagnosis**

| | MORPHO-LOGY | KINETICS | COMBI-NATION |
|---|---|---|---|
| BENIGN | 21 | 13 | 22 |
| MALIGNANT | 6 | 4 | 8 |

## BENIGN LESIONS

- Out of 22 benign lesions 3 lesions were diagnosed as fibroadenoma. On MRI All of them had oval shape with smooth margins & had non enhancing internal septations within. Time Intensity curve showed Type I curve in all of them. All three lesions were diagnosed as BIRADS II on mammography. Figure 1 shows the T1 image of fibroadenoma

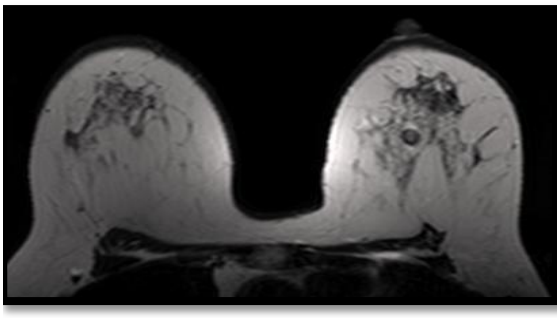

**Figure 1: T1 image of fibroadenoma.**

- Out of 22 lesions 3 lesions had histopathological diagnosis of phyllodes tumor. All patients had lobular shape, smooth margin & non enhancing fluid cleft within. Time Intensity curve showed type I pattern of enhancement in 1 patient & type II curve in 2 patients. Figure 2 shows MR imaging of phyllodes tumor.

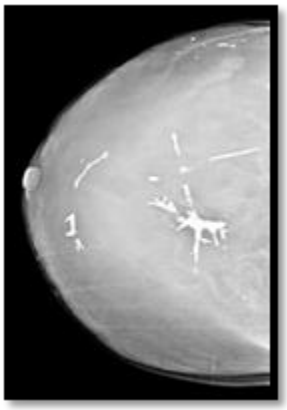

**Figure 2: MR imaging of phyllodes tumor.**

- Out of 22 lesions, 6 lesions were diagnosed as infective/inflammatory lesions. Among them 4 lesions had heterogeneous enhancement with few non-enhancing areas within, 1patient had homogenous enhancement & one patient had diffusely scattered multiple enhancing foci in both breasts. Out these patients 4 patients had benign axillary lymphadenopathy .Time Intensity curve showed type I pattern of enhancement in 4 patients & type II curve in 2 patients. Not all the cases were confidently diagnosed on mammography as inflammatory lesions.

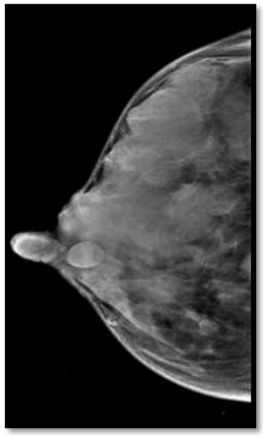

**Figure 3: MR imaging suggestive of duct ectasia.**

- Out of all benign lesions 3 lesions were diagnosed as duct ectasia. All of them had tortuous & tubular in shape with smooth margins & had non enhancing internal fluid within. All of them were hypointense on T1WI & hyperintense on T2WI.One of them had surrounding enhancement to suggest possibility of inflammation. Time Intensity curve showed Type I curve in 2of them & type II curve in the other one. One of the cases could not be diagnosed as duct ectasia on mammography because of dense breast parenchyma. Figure 3 shows MR imaging suggestive of duct ectasia.

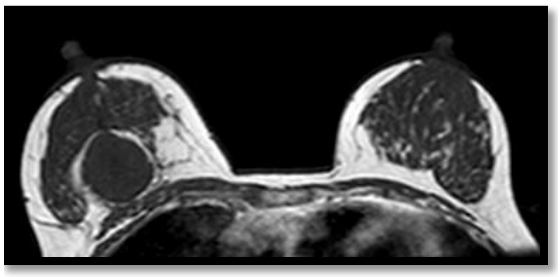

**Figure 4: MR imaging of a patient with soft tissue sarcoma of breast.**

- Out of 28 patients 6 patients had fibrocystic changes all of them had multiple non enhancing small simple cysts scattered diffusely in both breasts. One of these patients developed large simple cysts. In this particular group also one patient could not be evaluated properly on mammograph because of dense breast parenchyma.
- One patient with history of left mastectomy for invasive ductal carcinoma referred for MRI breast for evaluation of progressively increasing micro-calcification in right breast. The patient had no abnormal enhancement on post contrast study .These calcifications were confirmed as benign calcification on biopsy after hook wire localization. Inadvertent surgery was avoided in this patient.

## MALIGNANT LESIONS

- Out of 30 lesions in 28 patients 8 patients had histopathological diagnosis of malignancy.7 patients had diagnosis of Infiltrating Ductal carcinoma, 1 patient had diagnosis of primary soft tissue sarcoma of breast. Figure 4 shows MR imaging of a patient with soft tissue sarcoma of breast.

**Table No.7:** Mammography description of lesion using BIRADS lexicon

| Feature | Characteristic | | Benign | Percent | Malignant | Percent |
|---|---|---|---|---|---|---|
| Shape | Round/oval | | 6 | 27.2% | 0 | 0% |
| | Lobulated | | 6 | 27.2% | 3 | 37.5% |
| | Irregular | | 2 | 9% | 3 | 37.5% |
| Margin | | | | | | |
| | Smooth | | 13 | 59% | 2 | 25% |
| | Irregular | | 1 | 4.5% | 2 | 25% |
| | Spiculated | | 0 | 0% | 3 | 37.5% |
| Calcification | | | | | | |
| | Micro | Segmental | 1 | 4.5% | 1 | 12.5% |
| | calcification | Regional | 0 | 0% | 1 | 12.5% |
| | Coarse calcification | | 2 | 9% | 0 | 0% |
| Architectural Distortion | | | 3 | 13.6% | 5 | 62% |

**Table No.8: Additional imaging findings identified on MRI/mammography**

| Feature | Axillary lymphadenopathy | | Chest wall involvement | | Skin Thickening | | | |
|---|---|---|---|---|---|---|---|---|
| Modality | Benign | Malignant | Benign | Malignant | Benign | | Malignant | |
| | | | | | Enhan-cing | Non enhan-cing | Enhan-cing | Non enhan-cing |
| MRI | 4 | 4 | 1 | 2 | 3 | 1 | 6 | 1 |
| Mammography | 4 | 4 | 0 | 0 | 4 | | 7 | |

- Out of all malignant lesions, 6 patients had mass like enhancement; among them 3 patients had spiculated, 2 patients had irregular margin and 1 patient had smooth margin.
- 2 patients out of 8 cases had non mass pattern of enhancement. Among them 1patient had regional pattern and 1 patient had segmental pattern of enhancement.
- Out of 8 patients 3 patients had heterogeneous enhancement, 3 patients had homogenous enhancement and 2 patients had rim like enhancement.
- Out of 8 patients with malignancy 4 had wash out pattern, 3 had plateau and 1had progressive pattern of signal intensity curve.
- Out of 8 patients with malignant lesion 7 had associated findings of skin infiltration,6 of them having enhancement to suggest malignant infiltration and 1 of them was non enhancing to suggest benign lymphedema of skin which down-staged the lesion.
- Out of 8 patients, 2 patients had chest wall invasion which were not diagnosed on mammography and lesions were up-staged after MRI.
- Out of 8 patients, 2 patient reported as single malignant lesion in one breast on mammography diagnosed as multicenteric breast cancer on MRI which was proven both per operatively & histopathologically.

- Out of 8 patients. 1 patient with histopathologically proven invasive ductal carcinoma got MRI done prior to chemotherapy. On post chemotherapy follow up MRI complete disappearance of the lesion was noted where mammography was not much sensitive.
- In our study, one patient presented with lump & history of lumpectomy 3 year back at same site reported as BIRADS III lesion on mammography diagnosed as post operative scar on MRI & multiple follow-up imaging and radiation exposure could be avoided in this patient.
- Out of 30 lesions in 28 patients, 7 lesions were up-graded from BIRADS IV to V and 3 lesions were down-graded after MRI breast from BIRADS III to II, so MRI helped in more confident diagnosis of both malignant as well as benign lesions; unnecessary biopsy, multiple follow-ups and exposure to ionising radiation could be avoided in these patients. Out of 30 lesions 17 lesions had same BIRADS on MRI as compare to conventional mammography.

## DISCUSSION

Breast MRI offers information about many breast conditions that cannot be obtained from mammography or ultrasound, particularly in higher risk patients such as those that carry genetic susceptibility. Breast MRI is frequently performed at the time of diagnosis of all early breast cancer to identify contra lateral and additional ipsilateral disease. Similar results have been shown in study by Orel et al[7] and Nunes et al[8]. In the study by Nunes et al,[8] of 192 patients with mammographically visible or palpable findings who underwent breast MRI and subsequent excisional biopsy for histopathological confirmation, showed that smooth and lobulated borders in a focal mass were highly predictive of benign disease: irregular and spiculated borders were more characteristic of malignant disease. The presence of nonenhancing internal septations was associated with benign disease. The presence of peripheral rim enhancement was highly predictive of malignancy. Tozaki et al[9] assessed a new interpretation model that combines kinetic enhancement patterns and morphologic characteristics visualized using high spatial-resolution MR imaging. The morphological parameters consisted of lesion shape (round, oval, lobular, irregular), mass margin (smooth, irregular, speculated), rim enhancement (RE), and the presence of an internal signal on T2-weighted images. Lesion shape/margin was classified into four categories as follows: smooth (smooth/round or smooth/oval), lobulated (lobular shape), irregular (irregular margin or irregular shape), and speculated (speculated margin). The most frequent types of lesion shape/margin among the malignant lesions were irregular (47%) and speculated (43%). Rim enhancement was sub-classified as early RE at 60 sec and delayed RE at 4 min (positive or negative). The presence of very high signal intensity was evaluated over the entire lesion on T2-weighted images (positive or negative). If very high signal intensity was observed inside the lesion, the presence of internal black septations was evaluated (positive or negative). The kinetic enhancement parameters were evaluated as exhibiting either washout, plateau, or progressive characteristics. The presence of early RE was found in 29% of the benign lesions and 51% of the malignant lesions.

In study by Orel et al[7] of forty-one patients with mammographic and/or palpable lesions which were imaged and all patients underwent excisional biopsy. Of the 16 carcinomas that were identified at MR imaging, the borders were irregular in 13, five demonstrated inhomogeneous enhancement and four demonstrated rim enhancement. Internal septations in five of the nine visualized fibroadenomas were seen. This morphologic characteristic was seen only in fibroadenomas and could be correlated histologically with fibrous septa between adjacent lobules of the fibroadenoma.

Our study revealed that the enhancement kinetics as shown by time signal intensity curves differ significantly for benign and malignant enhancing lesions, so can be used as aid in differential diagnosis. In breast cancers washout and plateau curves prevail and benign lesions show progressive enhancement. Shah et al[10] stated that in patients with already

diagnosed breast cancer, the use of MRI may help to provide optimal therapy for patients. MRI has been shown to be more accurate compared with mammography or ultrasound in detecting the size and extent of the lesion. In addition, MRI is useful in the identification of multicentric disease, which may have an impact on the type of therapy, e.g. radical mastectomy versus more conservative surgery. MRI is helpful in detecting pectoral muscle and chest wall involvement of breast cancer. Nipple involvement, which is important to know when planning subcutaneous mastectomy or breast conserving surgery, can also be clarified with MRI.

In our study, histopathological diagnosis of phyllodes tumor breast when analyzed by time signal intensity curves showed plateau curve in 2(66%) patients and progressive pattern in 1 patient (33%). Histopathological diagnosis of fibro adenoma breast when analyzed by time signal intensity curves showed progressive pattern in all lesions. In malignant group 7 pts had histopathological diagnosis of infiltrating ductal carcinoma & 1 had histopathological diagnosis of primary sarcoma, out of which 4 showed washout curve (50%) and 3(37%) had plateau & 1(12.5%) showed progressive pattern.

The study supports the potential value of washout suggested by Orel et al.[7] In their study group, 83% of the benign lesions exhibited a steady or curved time–signal intensity curve. In contrast, 57% of malignant lesions exhibited a washout time–signal intensity curve. Using the shape of the time–signal intensity curve alone, the authors report a sensitivity of 91% (92 of 101), a specificity of 83% (137 of 165), a positive predictive value of 77% (92 of 120), a negative predictive value of 94% (137 of 146), and a diagnostic accuracy of 86% (229 of 266). The likelihood of breast cancer associated with a type I, II, or III time course was 6% (nine of 146), 64% (34 of 53), and 87% (58 of 67), respectively.

Similar results were also shown in a study by Kuhl et al,[11] two hundred sixty-six breast lesions were examined with a two-dimensional dynamic MR imaging series and subtraction post processing. There were 101 malignant and 165 benign lesions. The distribution of curve types for breast cancers was type I, 8.9%; type II, 33.6%; and type III, 57.4%. The distribution of curve types for benign lesions was type I, 83.0%; type II, 11.5%; and type III, 5.5%. The distributions proved significantly different ($P < .001$). The diagnostic indices for signal intensity time course were sensitivity, 91%; specificity, 83%; and diagnostic accuracy, 86%. The diagnostic indices for the enhancement rate were sensitivity, 91%; specificity, 37%; and diagnostic accuracy, 58%. Standartskjold et al[12] and Kerlikowske et al[13] stated that sensitivity and specificity are highly dependent on the composition of the breast parenchyma, which is influenced by age, hormonal status and possible previous interventions. In young women, the usefulness of mammography is restricted by high prevalence of dense fibro glandular tissue, which impairs both the detection and the differentiation of the lesion. Hormonal replacement therapy may also affect density.

Evaluation of tumor spread to adjacent structures is important preoperative information for the surgeon. In our study, we detected chest wall involvement and nipple retraction and skin infiltration in 7out of 8 cases with diagnosis of malignant disease.

Similar results were shown by Morris et al [14] and Orel et al[15], where MR imaging was able to contribute important local staging information for those with posterior breast tumors. In this study MRI could correctly diagnose all cases; hence sensitivity & specificity of MRI breast would be 100%. On mammography, 2 patients were diagnosed as suspicious lesion (BIRADS IV) turned out to be benign on MRI one was just benign calcification with no abnormal enhancement & one was inflammatory lesion. Because of these 2 false positive cases, specificity of mammography in this study is 90%. In 2 patients mammography was inconclusive because of dense breast. Because of these 2 false negative cases, sensitivity of mammography in this study is 80%.

In this study morphological analysis alone was sufficient for diagnosing benign lesion in 21 lesions out of 22 benign lesions, & in 6 out of 8 malignant lesions. Kinetic analysis alone could categorize correctly in only 13 out of 22 benign lesions 6 out of 8

malignant lesions. Combination of both could categorise all of the lesions correctly.

Our study has some limitations that need to be discussed. First, it may not directly reflect the general population it being a small study group and some sampling bias may have occurred as most of the cases were referred with established diagnosis either for confirmation or for pre operative assessment.

## CONCLUSION

MR imaging can be utilised as an important breast imaging modality as complimentary tool. Both malignant and benign lesions are identified more confidently with high-resolution MR imaging compared to conventional mammography. In case of non palpable, the diagnostic accuracy of MRI is superior to mammography. The identification of specific morphologic features can aid in the differentiation of malignant from benign lesions. Morphologic analysis of dynamic contrast enhanced MRI scores over kinetic analysis of time signal intensity curves. MRI is particularly of immense help in young patients with dense breasts and in inflammatory, painful breast conditions where mammography has limited role. The sensitivity of breast imaging can be increased by complementary use of MRI.

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